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OCCUPATIONAL MORTALITY AND CAUSES OF DEATH.*

BY DR. JACQUES BERTILLON,
Chief, Bureau of Municipal Statistics, Paris.

[Dr. Jacques Bertillon, as the representative of France, gave an evening address at the recent International Congress on Hygiene and Demography upon "Occupational Mortality and Causes of Death," the English translation of which will shortly appear in the Proceedings of the Congress. It was suggested that this article, being of great interest to statisticians, might be reprinted by the Statistical Association. But since it was delivered Dr. Bertillon has treated the subject more elaborately in the *Recueil de Statistique Municipale de la Ville de Paris*, Vol. III, No. 4, pp. 1-186. In view of this fact the general explanations prefacing his extended discussion are submitted to the members of the American Statistical Association in the hope that the translation may interest American students in a field upon which our own figures throw very little light, may lead many to a study of the full article, and may warn some against the many pitfalls with which this field of statistics is strewn. WALTER F. WILLCOX.]

Although the study of mortality and of the causes of death by occupation is of the first importance from the standpoint of social progress, the tabulations that permit it are very few. Statisticians have been prevented from pursuing the investigation by its extreme difficulty.

Sources. Only two statistical bureaus (that of the City of Paris and that of England and Wales) give information about the chief causes of death that affect the main occupations. (In Switzerland information is given only for tuberculosis and deaths from violence.)

Tabulations giving the statistics of deaths without specifying the cause are a little less rare.

The best tabulations which we have been able to use in the

*Translated by Kate M. Schutt.

study of occupational mortality are four collections of English figures, the first published by the illustrious William Farr (1860-61 and 1871), the second by his successor Ogle (1880-82), and the figures collected by Tatham (1890-92 and 1900-02). In the three later periods the principal causes of death have been distinguished (in 1880-82 as an experiment only).

The Scotch statistics furnish analogous information to that of the English for 1890-92 and 1900-02, those years having been chosen for this study because they are near a census. The results agree remarkably with the English.

The *Statistische Monatschrift* has published a table of mortality of the workingmen of Vienna.

In Switzerland a table of occupational mortality was given by Kummer and his successors during the twelve years 1879-1890.

I am the author of two tables of occupational mortality from tabulations made by the City of Paris; the one is a report for the five years 1885-9 (near the census of 1886)—the first table of its kind made in France; the other relates to the years 1890-9 and distinguishes the causes of death.

Recently statistics have been published for the City of Leipzig and its suburbs showing the mortality and morbidity for each occupation by age and, unfortunately, not by disease but by groups of diseases. The plan of these statistics is excellent; unfortunately the number of years of life observed is much too few to make the study serviceable.

Finally, just as this work is sent to the printer, the General Statistical Office of France furnishes us a table of mortality by age and occupation based upon figures for 1907 and 1908.*

I shall collate the results of these twelve tables, comparing the figures for each occupation with the general average for the country. Frequently I have found that the same occupations in different countries give analogous results.

I have compared these results with two tables of occupational morbidity drawn up by Bodio from the experience of Italian benefit societies.

The Prudential Insurance Company of Newark published in 1912 three important diagrams relative causes of death by occupation. Unfortunately the number of lives at risk is not known.

Before beginning this comparison, it is proper to put ourselves on guard against the numerous causes of error which the figures present.

Technical difficulties. Nothing requires more discrimination than the construction of tables of occupational mortality. It can truly be said that they are built upon shifting sand. Obviously the calculation of this ratio, "To 1,000 butchers, how many butchers died?" presupposes that one knows: (1) the number of butchers living; (2) the number who died. Now, one cannot know either of these numbers exactly. In fact, on the census day a certain number of butchers think they answer the question about their occupation correctly with the word "merchant" without saying what sort of business they carry on; while their clerks call themselves "employees" without saying in what sort of employment they are engaged. So one cannot know exactly the number living in each occupation. For similar reasons one cannot know any better the number dying in each occupation.

But worse still. In the preceding it would not be half so bad if we could be certain that the same individual who on the census day pompously declares himself a "merchant" will be designated as a merchant on his death certificate. Unfortunately nothing assures us that he will be.

On the other hand, frequently one person is engaged in several occupations at a time; in that case, it is a rule that the principal one should be reported. But who can say whether the occupation reported as principal on the census day will be considered the principal one on the day of death?

The importance of these difficulties should not be exaggerated. A declaration of the occupation is demanded many times in ordinary life; it serves as a sort of complement to the family name as a means of fixing identity. Therefore most men shape a customary answer from which they do not readily depart. Then, if the question relative to occupation is asked in the same way on the census schedule and on the certificate of death, it is likely that the answer will be the same. This will be very brief and probably incomplete, but it will be uniform.

From these considerations the following conclusion may be

drawn: "It is wise not to calculate mortality except for the most clearly defined occupations."

That is the reason for the extreme care with which William Farr set about the construction of his tables. In 1860-61 he calculated the mortality for only a score of occupations chosen from among the best defined. The agreement of the results of 1871 with the earlier ones showed the advantage of extending these studies. Ogle and Tatham, although they fully recognized the difficulty of the problem, were able to extend their investigations to a hundred occupations. The Swiss table likewise has been purposely confined to a limited number of occupations.

Of the 236 occupations distinguished by the Parisian census of 1886 and by the classification of deaths worked out under my direction, I preserved only 43 in my table for 1885-9 and 57 in that for 1890-9.

To this difficulty another is added against which it is easier to be on guard. The lists of occupations often distinguish the industrial occupation from the commercial; but in practice the distinction is very difficult, for, in ordinary usage, the manufacturer of hats and the merchant who sells them both call themselves *hatters*; in the same way, the words, *hosiers*, *clothiers*, *jewellers*, etc., are applied to those who manufacture and those who merely sell. So confusion is inevitable. Therefore, to get the figures for my table I have always combined merchants and those engaged in manufacturing the same articles. The same is true of the English nomenclature, which almost always confuses manufacturers and merchants under generic titles such as "engaged in iron," "engaged in wool," etc.

Difficulties of interpretation. Finally, if we have exact and adequate figures, difficulties of interpretation present themselves.

Above all, it is essential that occupational mortality be studied by age. If age is not distinguished, one will find that landlords, for example, show a high mortality. In their occupation, which is not at all laborious, there is nothing unhealthful. Their high mortality arises solely from the fact that landlords are for the most part aged men, enjoying in

their old age what they have acquired in earlier years. They have, then, the mortality of the aged, because they are old. If their deaths be classified by age, their death rate at every age will be found very low. On the other hand, if the deaths of soldiers be studied without distinction as to age, a low death rate is found; that depends solely upon the fact that soldiers are usually young; if their deaths be classified by age, their death rate is found to exceed the average showing that, despite the progress of military hygiene, the military profession is quite unhealthful.

We have to reject a great many studies of occupational morbidity and mortality, because this indispensable distinction has not been made. In my opinion, such studies are of no service.

At the same time, a table of occupational mortality classified by age is very difficult to interpret. If the figures are entirely accurate; if they are large enough to permit conclusions to be drawn; and if for a given occupation we find similar results in many countries, our task will not be ended. It will not yet be proved that we have found a measure for the degree of healthfulness of that occupation.

The situation is this: some occupations demand that those who carry them on should be strong. Why should it be surprising that their mortality is low? That does not signify that the occupation in question is healthful, but only that those who engage in it have been selected from among the country's strongest men. Here again the classification by age is valuable. If such an occupation is unhealthful, the mortality will be low in youth (because the selection of the better stock will produce that result) and will rise rapidly from the 25th or 30th year. That will be evidence that the occupation is unhealthful. But that evidence will fail when the occupation demands so much strength that men who have become enfeebled must enter another occupation. In that case the figures will deceive us entirely, and the death rate at each age will be low, although the occupation is unhealthful.

On the other hand, sedentary occupations which do not necessitate hard muscular effort are sought by weaker persons who have neither the ability nor the inclination to work very

hard. Such are the occupations of the tailor, shoemaker or clockmaker. Why should it be surprising if these show a large proportion of deaths? That high mortality proves the weakness of those who enter the occupation but does not prove that the occupation is unhealthful. Here the study of the mortality by age will be helpful. If such an occupation is healthful in itself, we shall find a somewhat high mortality in youth, but (after the supply of consumptives and other invalids shall have been exhausted) a lower mortality at succeeding ages.

But this is not always so. Some occupations easy to learn become the refuge of the weak after they have broken down in some other. Such are those of huckster, pedlar, day laborer, etc. Those occupations have a high mortality at all ages, but this does not show them to be unhealthful. It is those who engage in them who are unhealthy.

The difficulties mentioned, which render the construction and interpretation of occupational mortality tables so dangerous, are even more serious for women than for men. So, like my English and Swiss predecessors, I have given up computing any figures for women. My tables apply only to males.

Necessity of comparing the figures for any occupation with a corresponding average. In this comparison one must not forget that, other things equal, the average mortality at each age in Paris is much higher than in the mountains of Switzerland or even in England. So, we must expect that, other things equal, an occupation will show a higher mortality in Paris than in Switzerland. Consequently for the comparisons we are undertaking, attention must be fixed constantly upon the average male death rate of the region under consideration. This general mortality for each age is the average male death rate at that age in the region under consideration; the death rate of each occupation, compared with this general average, indicates what the occupation adds to or subtracts from this average mortality.

Does one want to determine the mortality of Swiss printers? Their mortality at each age is compared with the general mortality of Swiss men at the same age; it is found that their death rate is high. Does one next wish to see if the same is

true in Paris? The death rate of Parisian printers at each age is likewise compared with the average Parisian death rate at the same age. It is found also that the mortality of Parisian printers exceeds perceptibly the average for Paris. It is the same in England, and we must conclude that this occupation is unhealthful in the three countries studied. On the other hand, one does not reach a significant conclusion by comparing the mortality of Swiss printers with that of Parisian printers. One should, then, compare the death rate of Swiss printers with that of Swiss men of the same age and note the difference between them; then compare the death rate of Parisian printers with that of Parisians of the same age, and note the difference between them; one finds, as I have said, that the difference is of the same nature. In general it appears that the occupations which are unhealthful in Switzerland and in England are equally so in Paris.

Numerical interpretation of my statements. The exact meaning of the verbal expressions I shall use is apparent from the preceding considerations. The words "very frequent," "frequent," "rare," "very rare," employed to indicate the degree of frequency of a cause of death in a given occupation, are equivalent to the more exact phrases: "much exceeds the general average for males," "exceeds perceptibly," "is perceptibly less" or "is much less." The words "average frequency" mean "deviates little from the average."

One may say, *e. g.*, that valvular diseases of the heart are very frequent among fishermen (*i. e.*, they are much more frequent among them than they are on the average among other men) and that tuberculosis is very rare among them (*i. e.*, much more rare than among other men), although to 100,000 years of life at age 35-44, tuberculosis causes 194 deaths among fishermen and valvular diseases of the heart only 62.

A uniform rule has been followed in the choice of the words "very frequent," "frequent," "rare," "very rare."

To facilitate the reading of my tables, figures representing the expressions "rare," or "very rare" have been set in italics; those representing "about the average," in Roman type; and those representing the words "frequent" or "very frequent"

in bold-faced type. Finally, heavy type is reserved for the figures representing exceptionally low or high rates.*

The classification of occupations from the sanitary point of view.

We have seen that in each occupation it is necessary to estimate the frequency of each disease at each age. In order to draw general conclusions from this multitude of figures, it is indispensable to classify the occupations from the hygienic point of view.

Others who have attempted such a classification have simply mentioned the occupations affected by some special disease, such as malignant pustule among tanners, lead-poisoning among painters; they have had in mind also the causes commonly assigned for some common diseases, such as humidity as a cause of rheumatism, cold as a cause of pneumonia, dust as a cause of tuberculosis, and after this fashion they have classified occupations. Such a method is the best one available when statistics are lacking; nevertheless, it is very imperfect in assigning too much importance to certain occupational diseases which cause very few deaths. It makes a more serious mistake in that it conjectures what is probable instead of being founded upon the facts.

I have proceeded in a very different way. Taking statistical data as my starting point, I have classified occupations according to whether (1) tuberculosis is rare, of average frequency, or frequent. Within each of these three classes I have distinguished three groups according to the frequency of (2) other diseases of the respiratory system. In each of these new groups I have distinguished three sub-groups according to the frequency of (3) diseases of the circulatory system; and so I have proceeded to consider in turn the frequency of (4) diseases of the liver, of (5) nephritis, and of (6) diseases of the nervous system, more particularly after 40 years of age,

*These classes have been determined as follows: the minimum frequency is subtracted from the average and the difference divided by 5. Between the minimum value and that value plus $\frac{2}{5}$ of this difference is the class "very rare"; between that point and another $\frac{2}{5}$ is the class "rare." By adding another $\frac{2}{5}$ the average is reached. From the maximum value the average is subtracted and the difference divided by 5. To the average $\frac{2}{5}$ is added to obtain the upper limit of the class "average"; another $\frac{2}{5}$ is added to obtain the upper limit of the class "frequent" and another $\frac{2}{5}$ to get the upper limit of the class "very frequent." The classes "exceptionally high" and "exceptionally low" cannot be measured.

i. e. ,when the occupation has had time to show its good or bad influence.

By making three classes under each of these six groups of causes of death I have made $3^6 = 729$ sub-groupings of occupations. The occupations then group themselves so naturally that, despite appearances, it is easy to summarize this great table under three groups: A—Occupations in which tuberculosis is very common or of average frequency; B—Occupations in which tuberculosis is rare but diseases of the liver are common or of average frequency; C—Occupations in which tuberculosis is rare and diseases of the liver and kidneys are also rare.

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The entire study, introduced by the foregoing paragraphs, is divided into three parts. The first part examines in succession the several causes of death; the prevalence of each cause in the main occupations according to the English and the Parisian tables is presented and some general conclusions drawn. The second part, of which only selections have been published, examines in succession the several occupations; for each occupation the diseases to which it is subject are shown from the figures contained in the first part. In this way eleven occupations are examined. Most of the material necessary for a similar study of the other occupations can be found in the first and third parts. The third part is concerned with occupational mortality not distinguishing the causes of death, but comparing, so far as possible, the results found in the twelve published tables of occupational mortality.